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Surface anatomy for implantation of external ventricular drainage: Some surgical remarks

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Abstract

Background: External ventricular drainage (EVD) is an emergency process intended to reduce intracranial hypertension resulting from the obstruction of cerebrospinal fluid (CSF) flow. This creates a temporary situation to extract CSF that cannot pass through normally. Knowing the surface anatomy for EVD implantation is important to prevent its inadvertent complications. The external landmarks have been designed in this anatomic study to review the classical landmarks and come up with new landmarks to improve this simple but lifesaving procedure.

Methods: From November 1998 to October 2012, we implanted 439 EVDs.

Results: In the first years, we employed usual landmarks to implant 97 EVDs. Since 2002, we used modified anatomical landmarks to implant 342 EVDs directly in the third ventricle.

Conclusion: Using effective landmarks for EVD implementation allows the catheter to be inserted in the third ventricle. In addition, it permits more precise accuracy to ensure a safer procedure with fewer complications.

Key Words: Acute hydrocephalus, cerebrospinal fluid, external ventricular derivation, lateral ventricle, third ventricle

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INTRODUCTION

External ventricular drainage (EVD) is an emergency procedure aimed at reducing intracranial hypertension resulting from the obstruction of cerebrospinal fluid (CSF) flow. It is a relatively simple but lifesaving process. This process creates a temporary situation to extract CSF that cannot pass through normally.

The procedure consists of implementing a shunt in the right frontal horn of the lateral ventricle. It is usually done without any image guidance, which may be life-threatening.

The surgery is decided according to patient's clinical condition, his (her) clinical exam, and his (her) imaging [computed tomography (CT) scan or magnetic resonance imaging (MRI)].

Being considered a simple procedure, EVD implementation is made using surface anatomy. It is generally the first surgery carried out by young resident or neurosurgeons.

Although in a majority of instances lateral ventricle is dilated, the neurosurgeon is sometimes confronted by

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cases in which the frontal horn is normal even narrow. Therefore, knowledge of the cranium projections of brain structures is essential for the success of the surgery and reduces the surgical complications and misplaced catheter. With experience and by the logic and nature of diseases requiring the implementation of EVD, on one hand, and reflecting brain anatomy and the physiopathology of CSF circulation and absorption, on the other hand, we believe that the implementation of EVD in the third ventricle is the best way to have a situation as close to reality as possible.

This paper presents our experience, our knowledge acquired over the years, our remarks, and our conclusion about EVD implantation in the context of the literature.

MATERIALS AND METHODS

From November 1998 to October 2012, we implanted 439 EVDs. Pediatric cases were excluded from study. In the first years, we employed usual landmarks to implant 97 EVDs. Since 2002, we used modified anatomical landmarks to implant 342 directly in third ventricle.

According to usual landmarks, the patient is positioned in a dorsal decubitus, the head is slightly flexed with a 0 degree of rotation. The trepanation hole is made 2–3 cm lateral to the midline and 1–2 cm anterior to the coronal suture. The ventricular catheter is passed perpendicular to the brain. The surgeon enters the lateral ventricle at 5–6 cm from the calvarium.[1,3,5,11,13-16]

Since 2002, we employed the following technique and landmarks; for burr hole spacing, we choose a point 11.5 cm posterior to Nasion (measured by a flexible rule) at the midline. At this point, we choose a point 2.5 cm lateral to the midline and perpendicular to the latter. The burr hole is placed more or less at this point. The 3 cm curved incision is placed central to this point with its concave side facing anteriorly. We use a three-dimensional trajectory to first enter the lateral ventricle and then the third ventricle. For this purpose, we employ three references point in space. The first one is the inner canthus of the ipsilateral eye in the coronal plane. First, this point is targeted by the catheter. The second one is tragus in the sagittal plane. The trajectory is adjusted the second time to be parallel to tragus. And the third and last point in the space is the midpapillary point of the eye in axial plane. This point determines the exact placement of the burr hole that will be adjusted and referenced to the starting point (2.5 cm to midline). The burr hole is performed by twist drill. Dura is open by electric bistoury. The catheter is passed according to landmarks, point references, and abovementioned imaginary lines.

Once a slight resistance was felt, there will be immediately a popping as the ependymal layer is punctured. The catheter is pushed at 8.5–9.5 cm from calvarium to be placed gently in the third ventricle.

RESULTS

Table 1 shows the baseline of patients who have undergone the EVD implementation.

All the patients had a postoperative imaging (MRI or CT scan) at the latest 24 hours after surgery. If the patients did not improve or their neurological condition deteriorated, they had an imaging immediately after EVD implantation.

Table 2 demonstrates diseases requiring EVD implantation. Table 3 shows mechanical complication resulting from EVD implementation technique (misplaced catheter).

DISCUSSION

Over time, we modified our landmarks for EVD implantation. These modifications were carried out on the basis of the experience of EVD implementation but also, in particular, the experience of ventriculocysternostomy that need device introduction in the third ventricle. We noted that, with stringent compliance of landmarks and trajectories, we can enter the catheter in the third ventricle in the vast majority of cases without any difficulty. The interest of EVD implantation in the third ventricle is multiple; well-balanced extraction of CSF; non-unilateral evacuation, in particular, in the case of unilateral intracranial pressure due to tumor mass or other possible causes; and valve obstruction avoidance in case of lateral ventricular collapse. Obviously, there may be cases where EVD in the third ventricle is impossible. However, there have only been a handful of cases in our series.

Our three-dimensional landmarks provide the most precise accuracy against usual two-dimensional landmarks, and even more because this surgery is generally carried out as an emergency and would not always be possible to use neuronavigation and stereotaxic frame. Despite its reputation as a relatively simple procedure, this surgery is not an innocuous act and several complications have been identified in the medical literature. In addition to the general complications of EVD implantation as hemorrhage and obstruction, the most common misplaced catheters are basal ganglion, thalamus, internal capsula, corpus callosum, and frontal lobe.[1-6,8-20]

In our series of 342 patients using three-dimensional landmarks, we had only 3 (0.88%) misplaced catheters [Table 3] against 4 misplaced catheter (4.12%) for the usual technique.

Using usual technique, we were led to try a second even a third time to correctly place the catheter and see CSF

Table 1: Baseline of patients

Patients operated by the usual technique					
No of patients(%)	**A.1**	**A.2**	**A.3**	**LV**	
97 (100)	86 (88.66)	5 (5.15)	6 (6.18)	97 (100)	
Patients operated by the modified anatomical landmarks technique					
No. of patients(%)	**A.1**	**A.2**	**A.3**	**LV**	**3V**
342	331 (96.78)	9 (2.63)	2 (0.58)	18 (5.26)	324 (94.74)

Table 2: Diseases requiring external ventricular drainage implantation

Subarachnoid hemorrhage
hydrocephalus shunt malfunction
Shunt infection
Trauma
Intracranial hematoma
Subdural hematoma
Extradural hematoma
Tumor
Posterior fossa
Supratentorial tumor
Spinal tumor
Postoperative hydrocephalus

Table 3: Misplaced catheter resulting from external ventricular drainage implantation technique

Patients operated by the usual technique	
No. of patients	**Complications**
1	Catheter entered in the internal capsula
2	Catheter entered in the corpus callosum
1	Catheter entered in the basal ganglion
Total (%)	
4 (4.12)	
Patients operated by the modified anatomical landmarks technique	
No. of patient	**Complications**
1	Catheter entered in the corpus callosum
1	Catheter entered in the basal ganglion
1	Catheter entered in the frontal lobe
Total (%)	
3 (0.88)	

flow in 11 patients (11.33%) against 11 patients (3.21%) who were operated by modified anatomical landmarks technique. In this regard, we do not believe that this results were due to lack of experience because the authors had already implanted more than 100 hundred EVDs before the first series.

Some remarks

This surgery is performed in a patient in a dorsal decubitus position. The patient's head is in a straight up, slightly flexed position. Care must be taken to not bend the head that would increase intracranial pressure. In general, the surgery is carried out on the right side.[7] However, EVD implantation can be done on the left side if we are confident that the patient is left handed or when there is a brain disease prohibiting the introduction of the catheter on the right side such as arteriovenous malformation or intracranial hematoma. We first enter the lateral ventricle at 5–6 cm from calvarium. We feel a slight resistance and there will be immediately a popping as the ependymal layer is punctured. In this moment, we remove the stylus within the catheter to ensure that there is CSF flow. We replace the stylus and the catheter will be inserted for 2 cm. The stylus will be removed again, and from this moment onward, the catheter will be pushed very gently for 1–1.5 cm. The passage of catheter through the intraventricular foramen can be felt like a very slight resistance and sometimes a very feeble change in the direction of the catheter.

CONCLUSION

Using effective landmarks for EVD implementation allows the catheter to be inserted in the third ventricle. In addition, it permits more precise accuracy to ensure a safer procedure with less complications.

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Conflicts of interest

There are no conflicts of interest.

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